Attorney's Docket No.: 11223-002001 / 79 494 a/se

#3
3/3/00
P.W.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant : Charles C. Packham et al.
Serial No. : 09/422,758
Filed : October 21, 1999
Title : SHAVING SYSTEMS AND FOILS

Art Unit : Unknown
Examiner : Unknown

Assistant Commissioner for Patents
Washington, D.C. 20231

TRANSMITTAL OF PRIORITY DOCUMENT UNDER 35 USC §119

Applicants hereby confirm their claim of priority under 35 USC §119 from Great Britain Application Nos. 9708847.0 and 9708848.8 filed April 30, 1999. Certified copies of the applications from which priority is claimed are submitted herewith.

Please apply any charges or credits to Deposit Account No. 06-1050.

Respectfully submitted,

Date: January 5, 2000

Eric L. Prahl
Reg. No. 32,590

ELP/vbb

Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804
Telephone: (617) 542-5070
Facsimile: (617) 542-8906

20014469.doc

CERTIFICATE OF MAILING BY FIRST CLASS MAIL

I hereby certify under 37 CFR §1.8(a) that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage on the date indicated below and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

January 5, 2000
Date of Deposit

Signature

Vasilia B. Kelly
Typed or Printed Name of Person Signing Certificate

The Patent Office

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed A M Brewer

Dated 2 November 1999

Patents Form 1/77

Patents Act 1977
(Rule 16)

THE PATENT OFFICE 30 APR 1997 RECEIVED BY HAND

The Patent Office

01MAY97 E271590-1 D02656
P01/7700 25.00 - 9708847.0

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference — P12199 rl/rp

2. Patent application number *(The Patent Office will fill in this part)* — **9708847.0** 30 APR 1997

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

The Gillette Company
Prudential Tower Building
Boston
Massachusetts 02199
USA

Patents ADP number *(if you know it)* 07067602

If the applicant is a corporate body, give the country/state of its incorporation — USA (Delaware)

4. Title of the invention

SHAVING SYSTEMS AND FOILS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Hoffmann · Eitle
European Patent Attorneys
Sardinia House
52 Lincoln's Inn Fields
London WC2A 3LZ

Patents ADP number *(if you know it)* 07156466001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	0
Description	18
Claim(s)	4
Abstract	1
Drawing(s)	9 + 9

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature S J Avery. Date 29/04/97

12. Name and daytime telephone number of person to contact in the United Kingdom

S J Avery
Hoffmann · Eitle 0171 404 011

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) *If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.*

b) *Write your answers in capital letters using black ink or you may type them.*

c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

d) *If you have answered 'Yes' Patents Form 7/77 will need to be filed.*

e) *Once you have filled in the form you must remember to sign and date it.*

f) *For details of the fee and ways to pay please contact the Patent Office.*

Shaving Systems and Foils

This invention relates to shaving cutters, e.g. foils, and to shaving systems. Our copending application No. of even date (Our Ref.: P11909) describes methods of electroforming complex shapes, and the disclosure of that application is hereby incorporated herein by reference. The present application describes a shaving system using shaving cutters, which can be manufactured by the methods described in the copending application.

As explained in "VNR Concise Encyclopaedia of Mathematics" 2nd Edition (ISBN 0-442-20590-2) at pages 568 and 569, if the Gaussian curvature of a curved surface at a point P has the value k(P), three cases may be distinguished:

1. $k(P) > 0$, when the point P is called elliptic;
2. $k(P) < 0$, when the point P is called hyperbolic; and
3. $k(P) = 0$, when the point P is called parabolic.

This formal division has a close connection with the shape of the surface. For example, on a torus, the points towards the inside are hyperbolic and the points towards the outside are elliptic. These two sets of points are separated from one another by two circles which consist of parabolic points.

An ellipsoid has only elliptic points, a saddle surface has only hyperbolic points and a circular cylinder has only parabolic points.

In this specification, for convenience a surface region containing only elliptic points will be called an elliptic surface region, a surface region containing only hyperbolic points will be called a hyperbolic surface region and a surface region containing only parabolic points will be

called a parabolic surface region. Conventional shaving foils for oscillatory dry shavers almost invariably provide only parabolic surfaces. An exception is JP-A-7-646 (Japanese Patent Application No. 5-143093) which describes a foil having an elliptic surface.

In this specification, the expression "shaving cutter" is used to designate a foil-like cutter whether or not it is thin enough to qualify as a foil.

Although the surface regions of the human body which are habitually shaved are generally curved and uneven, the known shaving systems are not optimised for curved surfaces.

An object of the invention is to provide a shaving cutter, e.g. a foil, and a shaving system better adapted to shaving curved parts of the human body.

According to a first aspect of the invention, there is provided a shaving cutter comprising a shin-engaging surface which has both a convex elliptic region and a hyperbolic region.

Preferably, the elliptic region merges smoothly with the hyperbolic region.

In one embodiment, a concave parabolic skirt region depends from the hyperbolic region and a convex parabolic skirt region depends from the elliptic region. Preferably, the concave and convex skirt regions are concentric.

The cutter may further be provided with a pair of convex elliptic end cheeks each merging smoothly with the elliptic and hyperbolic regions.

According to a second aspect of the invention, there is provided a shaving cutter having a skin engaging surface which offers a convex first region which is parabolic or elliptic, a second region which is parabolic or hyperbolic, and first and second convex elliptic end zones merging smoothly with the first and second regions.

A respective skirt region may depend from each of the first and second regions.

In any of the above embodiments, the first and second regions are preferably perforate. Where the skirt regions are provided, these may also be perforate. If desired, the skirt regions may be provided with elongate hair capture slots.

According to a third aspect of the invention, there is provided a shaving cutter comprising:

first curved skin-engaging surface region;

a second curved skin-engaging surface region; and

the second surface region merging seamlessly with the first surface region;

there existing a cross-sectional plane intersecting the first surface region along a first curved line on which the first surface region is concave with a first radius of curvature and intersecting the second surface region along a second curved line on which the second surface region is convex with a second radius of curvature larger than the first radius of curvature.

According to a fourth aspect of the invention, there is provided a shaving cutter comprising:

a first surface region having two orthogonal planes of curvature, and being concave in one plane;

a second surface region having two orthogonal planes of curvature, and being convex in both planes; and

the first surface region merging seamlessly with the second surface region.

According to a fifth aspect of the invention, there is provided a shaving system comprising an outer cutter according to said first, second, third or fourth aspect, an undercutter conforming with the outer cutter and mounted for oscillatory movement beneath the outer cutter; and drive means for imparting said oscillatory movement to the undercutter.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made by way of example to the accompanying drawings in which:

Fig. 1 shows schematically an isometric view of a shaver foil curved in multiple dimensions;

Fig. 2 shows a plan view of the shaver foil of Fig. 1;

Fig. 3 shows a side view of the shaver foil of Figs. 1 and 2;

Fig. 4 shows a sectional view taken on the line Z - Z of Fig. 3;

Fig. 5 shows a plan view of the shaver foil of Figs. 1 to 3 provided with a trimmer on each of the curved side flanks of the foil;

Fig. 6 shows a side view of the shaver foil of Fig. 5;

Fig. 7 shows a sectional view taken on the line Z - Z of Fig. 6;

Fig. 8 is an isometric exploded view of a shaver head incorporating the curved shaver foil of Figs. 1 to 3;

Fig. 9 is a bottom view of the shaver head of Fig. 8 showing the undercutter movement;

Fig. 10 shows a straight shaver foil having curved end flanks;

Fig. 11 shows a longitudinal sectional view taken on the line A - A of Fig. 10;

Fig. 12 shows a cross-sectional view taken on the line B - B of Fig. 11;

Fig. 13 shows a triple-headed shaver head design in which each of the shaver units is straight;

Fig. 14 shows a longitudinal sectional view taken on the line Y - Y of Fig. 13;

Fig. 15 shows a cross-sectional view taken on the line Z - Z of Fig. 14;

Fig. 16 shows a shaver head having three shaver units, one of which is curved;

Fig. 17 shows a side view of the shaver head of Fig. 16;

Fig. 18 shows a sectional view on the line Z - Z of Fig. 17;

Fig. 19 shows a further shaver head having three shaving units, two of which are curved;

Fig. 20 shows a side view of the shaver head of Fig. 19;

Fig. 21 shows a cross-sectional view along the line Z - Z of Fig. 20;

Figs. 22 to 24 show three steps in a foil masked manufacturing process, in which Fig. 22 shows a shaped mandrel, Fig. 23 shows etching of a required foil pattern onto the mandrel of Fig. 22, and Fig. 24 shows the step of electroforming a mask onto the mandrel;

Fig. 25 shows a perspective view of a foil mask formed as shown in Fig. 24;

Fig. 26 shows an isometric view of a mandrel for use in forming the shaver foil of Figs. 1 and 2;

Fig. 27 shows an isometric view of the mandrel of Fig. 26 with the electroformed article;

Fig. 28 shows an exploded view of another shaver foil according to a further embodiment of the invention; and

Fig. 29 shows an assembled isometric view of the shaver foil of Fig. 28.

It has also now been recognised that producing a shaver foil in a curved "banana shape" may increase the effectiveness of shaving, particularly curved parts of the human body.

The advantage of the "banana shape" is that the shaver foil is curved along its length as well as having both concave and convex faces which can be used to shave different contours of the human body, especially the underarm and leg regions.

The shape also provides a contour of continually varying surface curvature which provides planar, concave and convex shaving surfaces, thus offering an improved ability to match the contours of the body, especially in difficult areas such as underarm, legs, neck, jawbone and upper lip, and giving an improved shaving performance.

Speaking mathematically, it may be said that the foil possesses a first region where the points of the surface are elliptic and a second region where the points of the surface are hyperbolic.

The concave and convex nature of the surfaces enable the foil aperture geometry to be optimised locally for specific areas of the body or face.

The foil may also be provided with closed "wrap around" end cheeks which offer an improvement in shaving comfort.

Referring now to Figs. 1 to 3, a banana shaped foil 111 is illustrated having closed convex elliptic end cheeks 112 and 113.

As shown in Fig. 1, the foil 111 includes a top surface 116, which is notionally divided by a line 117 into a first region 116a and a second region 116b. All points in the first region 116a are elliptic, whereas all points in the second region 116b are hyperbolic. The two regions 116a and 116b merge smoothly and seamlessly together along a line of parabolic points coincident with line 117.

A convex first side skirt 115 depends from and merges smoothly and seamlessly with the first region 116a, whereas a concave second side skirt 114 depends from and merges smoothly and seamlessly with the second region 116b.

The points of the first and second side skirts will be parabolic. Parabolic end skirts 118 and 119 merge smoothly and seamlessly with respective end cheeks 112 and 113 and

with the side skirts 114 and 115 which are thus linked together.

The top surface 116 will be perforated with non-elongate apertures of the size conventionally used in shaver foils, e.g. 400-800 mm diameter. The concentric concave and convex side skirts 114 and 115 may also be provided with hair receiving apertures of the conventional size. However, they may also be provided with elongate hair capture slots for improved capture of longer hairs. Such elongate slots may typically have dimensions 2000 mm(maximum) x 200 mm (minimum). The foil is manufactured by electroforming in one piece and is open at its base. By virtue of its shape, the foil has an arcuate longitudinal centre line, like a banana, and may be a sector of a toroid.

Where a toroidal sector is used, the circular centre line may have a radius of 50 mm. The body of the toroid may conveniently have a diameter of about 12 mm for a single foil device. These dimensions give an outer radius of the toroid of 56 mm. This outer radius should not be less than about 20 mm.

Fig. 4 shows a cross-sectional view through the foil, enabling the curved undercutter 41 and its drive arrangement 42 to be seen. These items will be described in more detail with reference to Fig. 8 and Fig. 9.

Fig. 5 shows how the curved foil 111 may be provided with a curved trimmer 51 on its convex side skirt and a further curved trimmer on its concave side skirt. The trimmer 52 on the concave skirt is more clearly visible in the side view of Fig. 6. Reference to Fig. 7 shows a cross-sectional view

both through the foil, the undercutter 41 and the two trimmers 51 and 52. As schematically illustrated in Fig. 7, the trimmers 51 and 52 are extensible and retractable in the direction of the arrow 71 in a manner known *per se*.

Fig. 8 shows an exploded isometric view of the components of the shaver head shown in Figs. 1 to 4. The foil 111 is received on and supported by a base plate 81 having an upstanding side wall 82. Within the foil is provided an arcuate undercutter 83 mounted on an undercut base plate 84 by respective coil springs 85 and 86. Each of the base plates 81 and 84 has a central aperture through which a drive pin extends to engage with the undercutter 83 and provide the required oscillatory motion.

The way in which the drive motion is achieved is better shown in Fig. 9. Fig. 9 shows a cross-sectional view through the shaver head 80 of Fig. 8. As shown, the curved undercutter 83 has blades 832 mounted on the base plate 831, and a drive slot 91 extends transversely through the base plate 831. A cam drive pin 92 engages the drive slot and caused to rotate in the manner shown by the arrow 93, thus causing reciprocation of the carrier 831 and undercutter in the direction of arrows 94 and 95.

Figs. 10 to 12 show a modified embodiment of the invention including a straight shaving foil 100 having a parabolic shaving surface and closed elliptic end cheeks 101, 102. Fig. 11 shows a longitudinal sectional view taken along line A - A of Fig. 10. The view of Fig. 11 shows the undercutter 118, which is constructed in a substantially conventional way. Fig. 12 is a cross-section taken along line B - B of Fig. 11.

Figs. 13 to 15 shows a shaving head having three shaving units 131, 132 and 133. Apart from possibly being of smaller diameter, each of the shaving units 131, 132 is constructed according to the design shown in Figs. 10 to 12, whereas the central shaving unit 133 is a long hair cutter of known design. The shaving units 131 and 132 will normally be constructed for shaving short hairs.

Figs. 16 to 18 show a further shaving system comprising three shaving units 161, 162 and 163. Shaving unit 161 is constructed according to the design of Figs. 10 to 12, whereas shaving unit 162 is constructed according to the design shown in Figs. 1 to 4, 8 and 9. Each of shaving units 161 and 162 is designed for shaving relatively short hairs. The central shaving unit 163 is however designed for cutting longer hairs. The cutter 163 differs from known cutters for longer hair in that the blades of the outer cutter of the unit are elongated towards each end in order to conform to the geometry of the curved short hair unit 162. The undercutter will however be driven to reciprocate linearly.

Figs. 19 to 21 show a further embodiment including three shaving units, in which the two outer units 191 and 192 are each constructed according to the design shown in Figs. 1 to 4, 8 and 9 and the central unit 193, for shaving longer hairs, has the shape of its outer cutter adapted to conform with the shape of the two short hair cutters 191 and 192. Again, the undercutter of unit 193 will be driven to reciprocate linearly, although an arcuate undercutter and movement on an arcuate path would also be possible.

Fig. 28 shows a foil 281 which represents a modification of the foil of Figs. 1 to 4 in which the end cheeks 112 and 113 are omitted, so that the foil 281 has open ends. This results in somewhat reduced structural rigidity. Accordingly, the foil is mounted on a frame 282 of synthetic plastics material having lateral lugs 283, 284 for engagement in securing apertures 285, 286 on the side skirts of the foil 281. It should be noted that although the foils described above are shown to have separate side skirts 114, 115, top region 116 and (where provided) end regions 112, 113, it is not essential for the side skirts 114, 115 to be distinct from the top region 116. It would equally be possible for the foil to be semicircular in cross-sections perpendicular to the longitudinal centre line.

Any of the curved banana shaped foils shown in Figs. 1 to 21 may be constructed using a method similar to that disclosed in the copending application No. (our reference P11909).

As described in that copending application, it is first necessary to make a foil head body mask and this is achieved by the steps shown in Figs. 22, 23 and 24.

It should be noted that if it is desired to produce an aperture of predetermined dimensions in the final electroform, e.g. a hair-capture aperture in a shaving foil, the corresponding aperture in the mask has to be made somewhat larger than the required final dimensions. When making a shaving foil, it is found that the mask apertures should be about 200μm larger than the desired dimension of the final product. For example, to produce a shaving foil aperture of diameter 600 μm a mask aperture diameter of 800 μm would be required.

Referring to Fig. 22, a mandrel 222 is made from a suitable material such as stainless steel or plastics material. When made of stainless steel, the surface should be polished to give a highly reflective fault-free surface for the application of electrophoretic photoresist. Where the mask is of plastics material, it is provided with a flash silver coating. As shown in Fig. 23, the required foil pattern 231 is then etched into the surface layer on the mandrel (silver coating or electrophoretic photoresist) using a laser in conjunction with a six axis table. Referring to Fig. 24, the mandrel is then supported on a base plate 241 and the required mask 242 is then electroformed onto the surface of the mandrel. It will be appreciated that where the mandrel is of plastics material provided with a silver coating, the electroforming builds up on the patterned silver layer. Where the mandrel is stainless steel coated with electrophoretic photoresist, the mask pattern builds up on the exposed portions of the stainless steel surface. Fig. 24 also shows one end of the mask cut away at 243 to show the mask material built up upon the surface of the mandrel.

If the mask is to be prepared on a stainless steel mandrel, the mandrel must be highly polished and coated with electrophoretic photoresist as described in the copending Application. An excimer laser, in conjunction with a six axis table, is then used to ablate the required pattern of the mask into the photoresist, resulting in the required mask pattern comprising exposed stainless steel, onto which the copper mask can be electroformed.

If the mandrel is silver coated, the required pattern is produced by ablating the negative pattern from the silver to

leave an electrically conducting silver pattern that is the same as the required mask.

If the mandrel is of stainless steel, it is prepared for electroforming the mask by the following steps:

1.1 Lightly abrade with "Sturcal"™ chalk;
1.2 Rinse with deionized water;
1.3 Dip in cold acid cleaner for 30 seconds;
1.4 Rinse in deionized water for 30 seconds;
1.5 Dip in cold alkali cleaner for between 30 seconds and three minutes;
1.6 Rinse in deionized water for 30 seconds;
1.7 Dip in cold acid cleaner for 60 seconds;
1.8 Rinse in deionized water for 30 seconds.

If the mandrel is silver sprayed plastics material, no abrading with "Sturcal"™ is performed because the abrasion may disrupt the integrity of the ablated pattern. Care must be taken to ensure the silver coating is kept as free from contamination as possible because only mild cleaning is possible. This can be effected by the following steps:

2.1 Dip the mandrel in cold alkali cleaner for between 30 seconds and two minutes;
2.2 Rinse the mandrel in deionized water for 30 seconds;
2.3 Dip the mandrel in cold acid cleaner for 20 seconds;
2.4 Rinse the mandrel in deionized water for 30 seconds.

In both cases, benefit may be obtained by dipping the mandrel in 5% potassium dichromate solution. This treatment provides a passivation layer which facilitates separation of the electroform from the mandrel.

The mask can then be electroformed as described below. Note that to ensure good metal distribution over the mandrel, it is beneficial to rotate the mandrel about the vertical axis during electroforming. The electroforming is performed by the following steps:

3.1 Electroform the pattern in copper from a dull acid electroplating solution comprising:

200g/l copper (11) sulphate
10g/l copper (11) chloride
30 ml/l sulphuric acid (SG 1.84)

at room temperature with a Cathodic Current density of 55mA/cm^2 for a time of 40 minutes;

3.2 Rinse the electroform in deionized water for 30 seconds;

3.3 Peel off the electroform from the stainless steel mandrel.

Following preparation of the mask, a polished mandrel is prepared for the application of electrophoretic photoresist as described in the following steps:

4.1 Clean the mandrel by rubbing with a slurry of "Sturcal"™ abrasive chalk;

4.2 Rinse with deionized water for 30 seconds.

4.3 Dip the mandrel in a hot alkaline cleaner (e.g. "Neutraclean"™) at 20-65°C for 60-180 seconds, preferably 60°C. for 2 minutes.

4.4 Rinse the mandrel for 30 seconds.

4.5 Dip the mandrel in a cold acid cleaner for 15-180 seconds at 20-30°C, preferably 1 minute at 20°C.

4.6 Rinse the mandrel for 30 seconds.

4.7 Dip the mandrel in "Rinse Aid"™ at 40-50°C for 60-180 seconds, preferably 40°C for 2 minutes.

4.8 Dip the mandrel in "Permeate Rinse"™ at 40-50°C for 60-180 seconds, preferably 40°C for 1 minute.

4.9 Soak the mandrel in "PCR 3000"™ electrophoretic photoresist at 20-60°C, preferably at 25°C for 60 seconds.

4.10 Apply a potential of 30V at 30A for 45 seconds. (Note the current falls to about 0.0-0.2A during this procedure.)

4.11 Dip the mandrel in "Permeate Rinse"™ at 40-50°C for 60-180 seconds, preferably 40°C for 1 minute.

4.12 Dip the mandrel in "Rinse Aid"™ at 40-50°C for 60-180 seconds, preferably 40°C for 2 minutes.

4.13 Rinse the mandrel in deionized water for 30 seconds.

4.14 Dry in an oven at 60-80°C for 10-15 minutes, preferably 75°C for 10 minutes.

4.15 Allow the mandrel to cool.

The mask, manufactured according to the method described in Figs. 22 to 24, is then mounted in a Perspex cap and applied to the photoresist coated mandrel before exposing the whole to ultraviolet light, for sufficient time to thoroughly expose the photoresist to the light, according to the following steps:

5.1 Expose the coated mandrel through photo-tooling artwork to UV radiation at 365 nm for sufficient time to achieve 1350 mJ/cm^2.

5.2 Develop the mandrel pattern in "Developer"™ at 20-50°C, preferably 26°C until the aperture pattern is just visible; note the time taken and continue the immersion for the same period.

5.3 Thoroughly rinse the mandrel and photoresist with deionized water.

5.4 Cure the photoresist at 160-200°C for 20-30 minutes, preferably 200°C for 30 minutes.

5.5 Allow to cool.

Fig. 25 shows the mask 242 with its foil aperture pattern 243. Fig. 26 shows the polished mandrel 261 coated with photoresist ready to receive the mask 242.

The mandrel 261 with its layer of developed photoresist is then prepared for electroforming as follows:

6.1 Clean the mandrel by rubbing with a slurry of abrasive chalk (e.g. "Sturcal"™).

6.2 Rinse the mandrel in deionized water for 30 seconds.

6.3 Soak the mandrel in cold acid cleaner as in step 4.5.

6.4 Rinse the mandrel in deionized water for 30 seconds.

6.5 Soak the mandrel in an alkaline cleaner as in step 1.5.

6.6 Rinse the mandrel for 30 seconds in deionized water.

6.7 Dip the mandrel in a cold acid cleaner as in step 4.5.

6.8 Rinse the mandrel in deionized water for 30 seconds.

Following the electroforming operation, a shaving foil 271 is generated on the mandrel as shown in Fig. 27.

Separation of the final electroform from the mandrel can be facilitated by the inclusion of a dipping step prior to the electroforming operation. The dipping step may be either chemical or electrochemical, in a solution of soluble dichromate salt or another suitable oxidising solution. Electroforming of the head is carried out in a nickel sulphamate bath at 60°C with a cathodic current density of 30-60mA/cm^2 for 90 to 180 minutes. The electroform can then be removed from the mandrel and mounted onto an undercutter assembly to form a shaving system as hereinbefore described.

For use in the above methods, the following materials may be obtained from the sources indicated:

	Material	**Source**
1)	Neutraclean™	Shipley Co.
2)	Rinse Aid™	Surcotech Ltd.
3)	Permeate Rinse™	Surcotech Ltd.
4)	PCR 3000™	Surcotech Ltd.
5)	Developer	Surcotech Ltd.
6)	Sturcal™	Rhone Poulenc.

Neutraclean™ is a trade name for essentially a solution of sodium metabisulphate in water.

Permeate Rinse™ is a trade name for an emulsion stabilizer containing lactic acid.

PCR 3000™ (sometimes known as PCT 3000™) is a trade name for an electrophoretic photoresist containing 1-methoxy-2-propanol ethylene glycol n-hexyl ether, acetone and lactic acid.

"Developer" is the developer supplied by the manufacturer of PCR 3000™ for use with that photoresist.

Sturcal™ is a trade name for ultrafine precipitated calcium carbonate.

The materials 2 to 5 are manufactured by LVH Coatings Ltd., of Coleshill, Birmingham, U.K. but are currently available from Surcotech Ltd., as noted above.

Claims:

1. A shaving cutter (111) comprising a skin-engaging surface (116) having both a convex elliptic region (116a) and a hyperbolic region (116b).

2. A shaving cutter according to claim 1 wherein the elliptic region merges smoothly with the hyperbolic region.

3. A shaving cutter according to claim 2 wherein the elliptic region merges with the hyperbolic region along a parabolic transition region (117).

4. A shaving cutter according to any one of the preceding claims wherein at least one of the surface regions is perforate.

5. A shaving cutter according to any one of the preceding claims wherein a concave parabolic skirt region (114) depends from the hyperbolic region.

6. A shaving cutter according to any one of the preceding claims wherein a convex parabolic skirt region (115) depends from the elliptic region.

7. A shaving cutter according to claims 5 and 6 wherein the concave and convex skirt regions are concentric.

8. A shaving cutter according to any one of claims 5 to 7 wherein the or each skirt region is perforate.

9. A shaving cutter according to claim 8 wherein the or at least one skirt region is provided with elongate hair-capture slots.

10. A shaving cutter according to any one of the preceding claims further comprising a pair of convex elliptic end cheeks (112, 113) each merging smoothly with the elliptic and hyperbolic regions.

11. A shaving cutter comprising a skin-engaging surface having a convex first region which is parabolic or elliptic, a second region which is parabolic or hyperbolic and first and second convex elliptic end zones merging smoothly with the first and second regions.

12. A shaving cutter according to claim 11 or 12 wherein a skirt region depends from at least one of the first and second regions.

13. A shaving cutter according to claim 11 wherein at least one of the surface regions is perforate.

14. A shaving cutter according to claim 13 wherein the or at least one skirt region is perforate.

15. A shaving cutter according to claim 14 wherein the or each perforate skirt region has elongate hair-capture slots.

16. A shaving cutter comprising:

first curved skin-engaging surface region;

a second curved skin-engaging surface region; and

the second surface region merging seamlessly with the first surface region;

there existing a cross-sectional plane intersecting the first surface region along a first curved line on which the first surface region is concave with a first radius of curvature and intersecting the second surface region along a second curved line on which the second surface region is convex with a second radius of curvature larger than the first radius of curvature.

17. A shaving cutter comprising:

a first surface region having two orthogonal planes of curvature, and being concave in one plane;

a second surface region having two orthogonal planes of curvature, and being convex in both planes; and

the first surface region merging seamlessly with the second surface region.

18. A shaving cutter substantially as hereinbefore described with reference to the accompanying drawings.

19. A shaving system comprising an outer cutter according to any one of the preceding claims; an undercutter conforming with the outer cutter and mounted for oscillatory movement beneath the outer cutter; and drive means for imparting said oscillatory movement to the undercutter.

20. A shaving system according to claim 19 wherein the outer cutter has an arcuate longitudinal centre line and the undercutter is correspondingly arcuate.

21. A shaving system according to claim 19 or 20 comprising first, second and third shaving units, at least one of which includes an outer cutter according to any one of claims 1 to 18 and a corresponding undercutter.

22. A shaving system according to claim 21 wherein at least two of the shaving units include an outer cutter according to any one of claims 1 to 18 and a corresponding undercutter.

23. A shaving system substantially as hereinbefore described with reference to Figs. 1 to 4, Figs. 5 to 7, Figs. 8 and 9, Figs. 10 to 12, Figs. 13 to 15, Figs. 16 to 18 or Figs. 19 to 21 or any of the foregoing modified in accordance with Figs. 28 and 29, of the accompanying drawings.

ABSTRACT

Shaving Systems and Foils

A shaving cutter (111) comprises a skin-engaging surface (116) having both a convex elliptic region (116a) and a hyperbolic region (116b). The elliptic region merges with the hyperbolic region along a parabolic transition region (117). Preferably, at least one of the surface regions is perforate. In addition, a concave parabolic skirt region (114) may depend from the hyperbolic region, while a convex parabolic skirt region (115) depends from the elliptic region.

(Fig. 1).

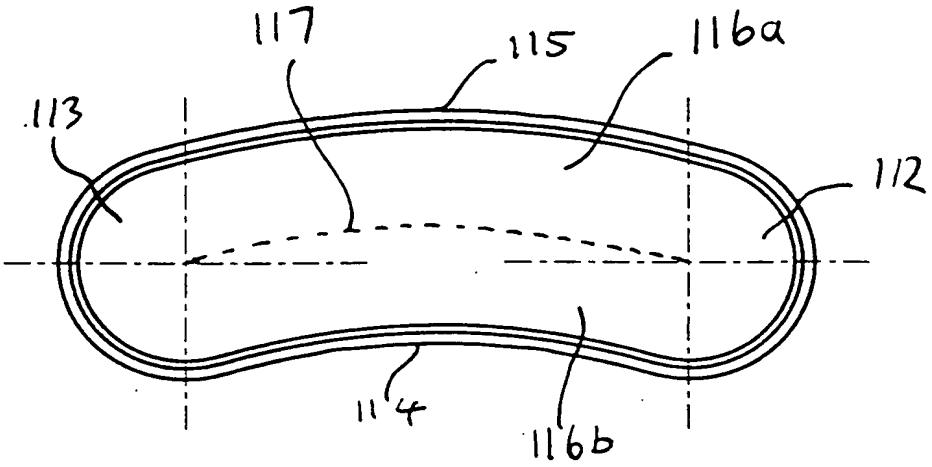


Fig. 2

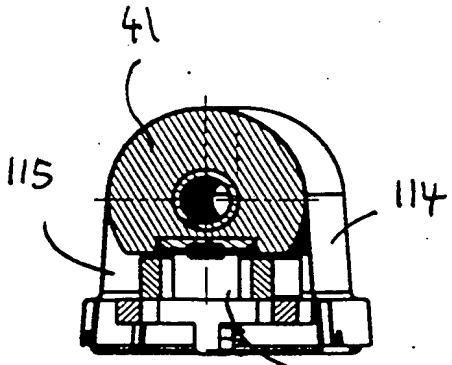


Fig. 4

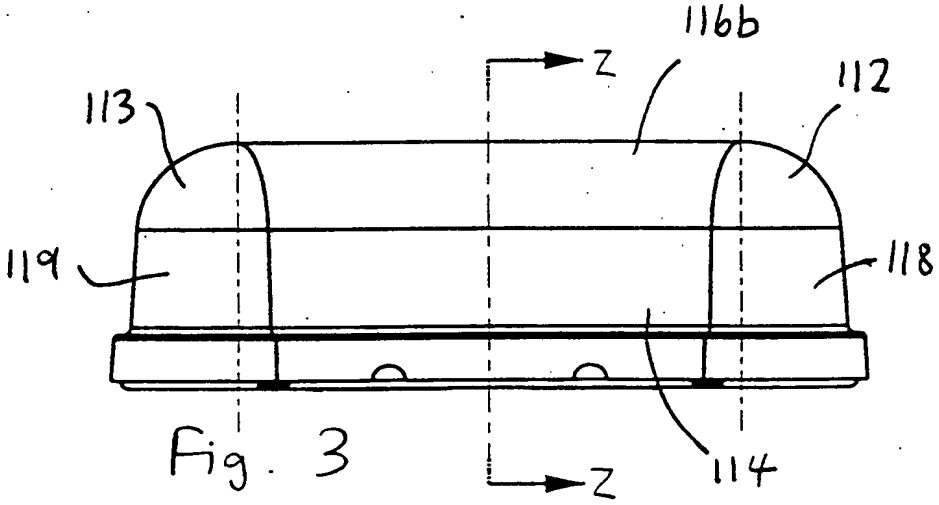


Fig. 3

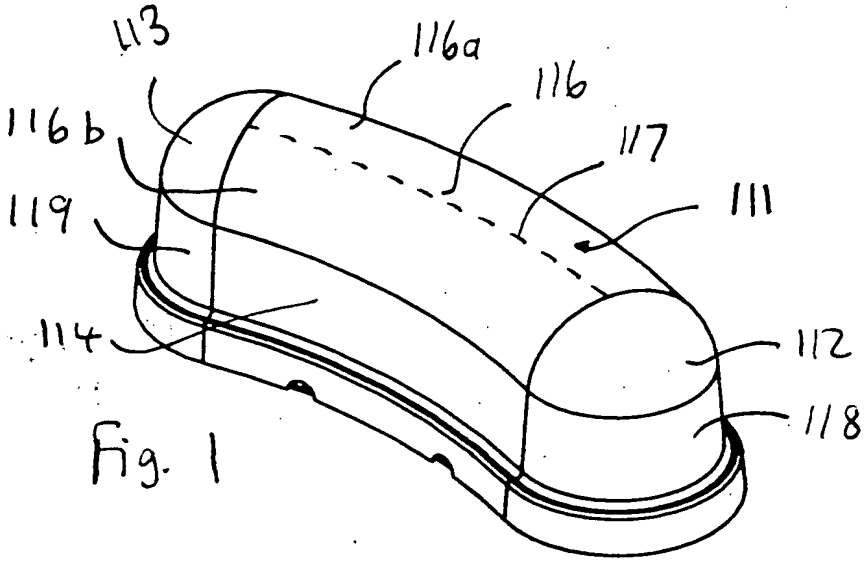
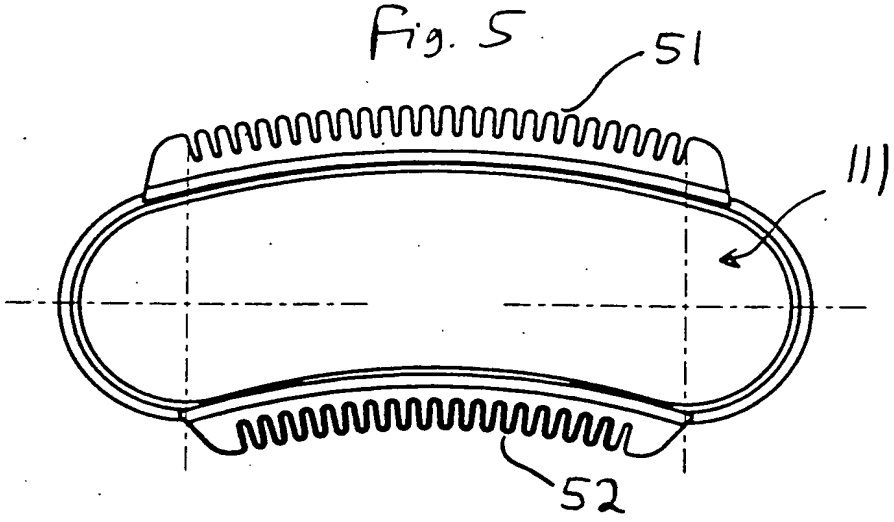


Fig. 1

Fig. 5



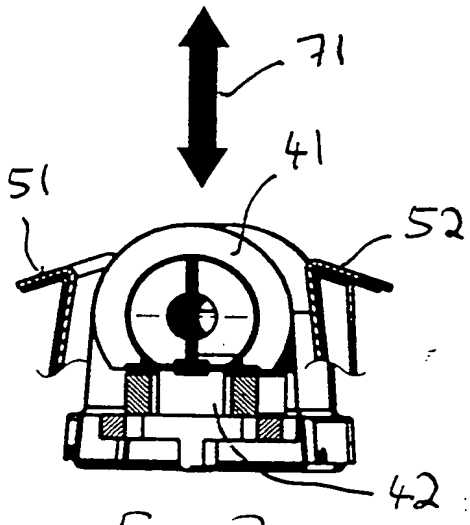


Fig. 7

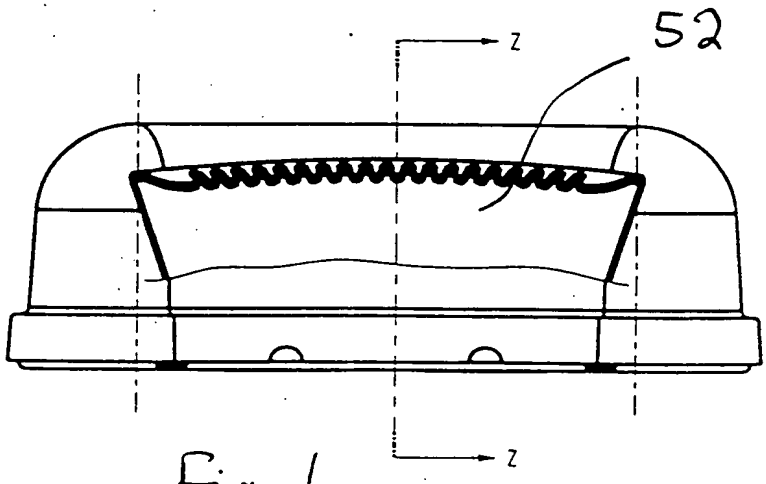


Fig. 6

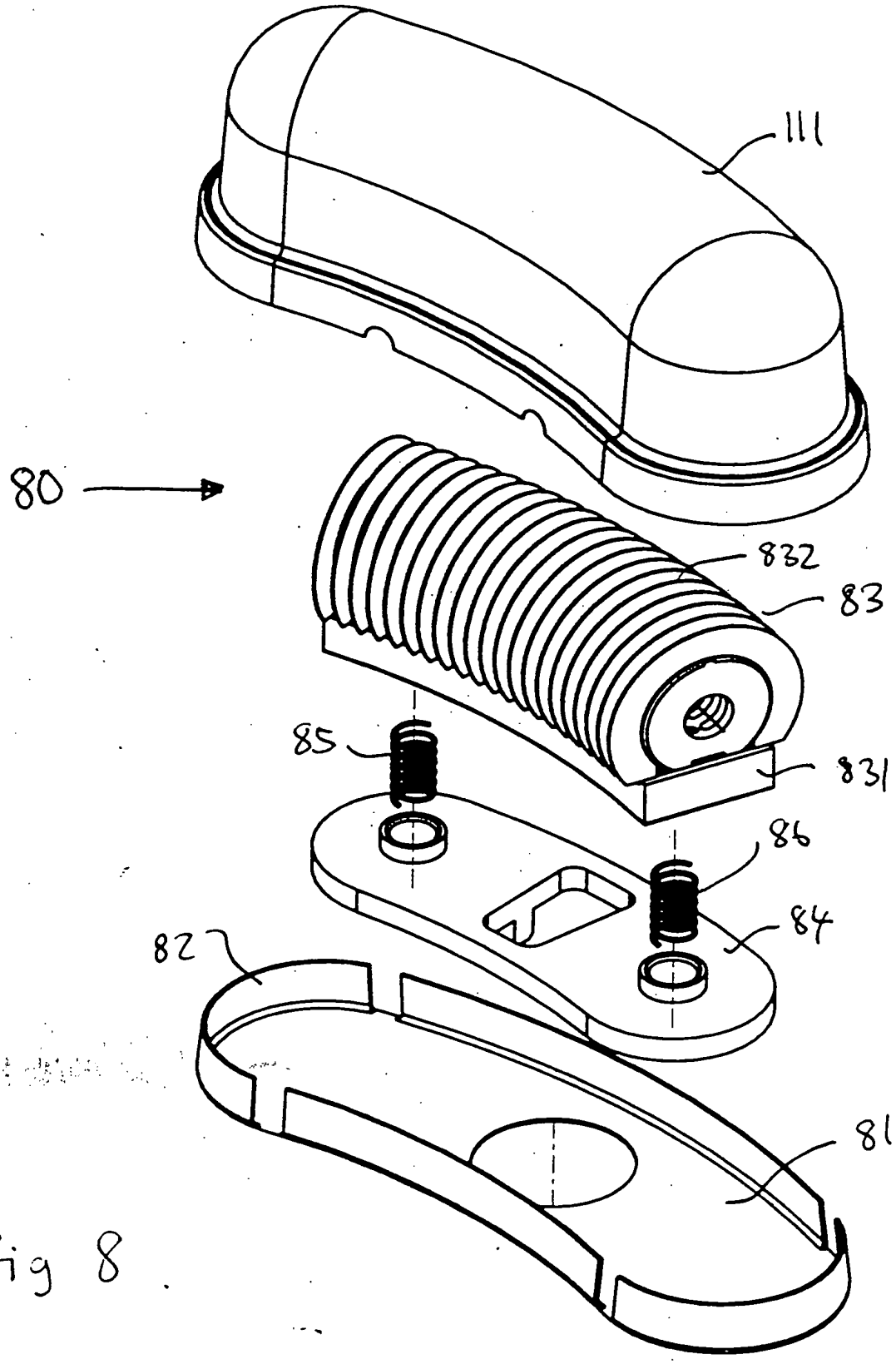


Fig 8

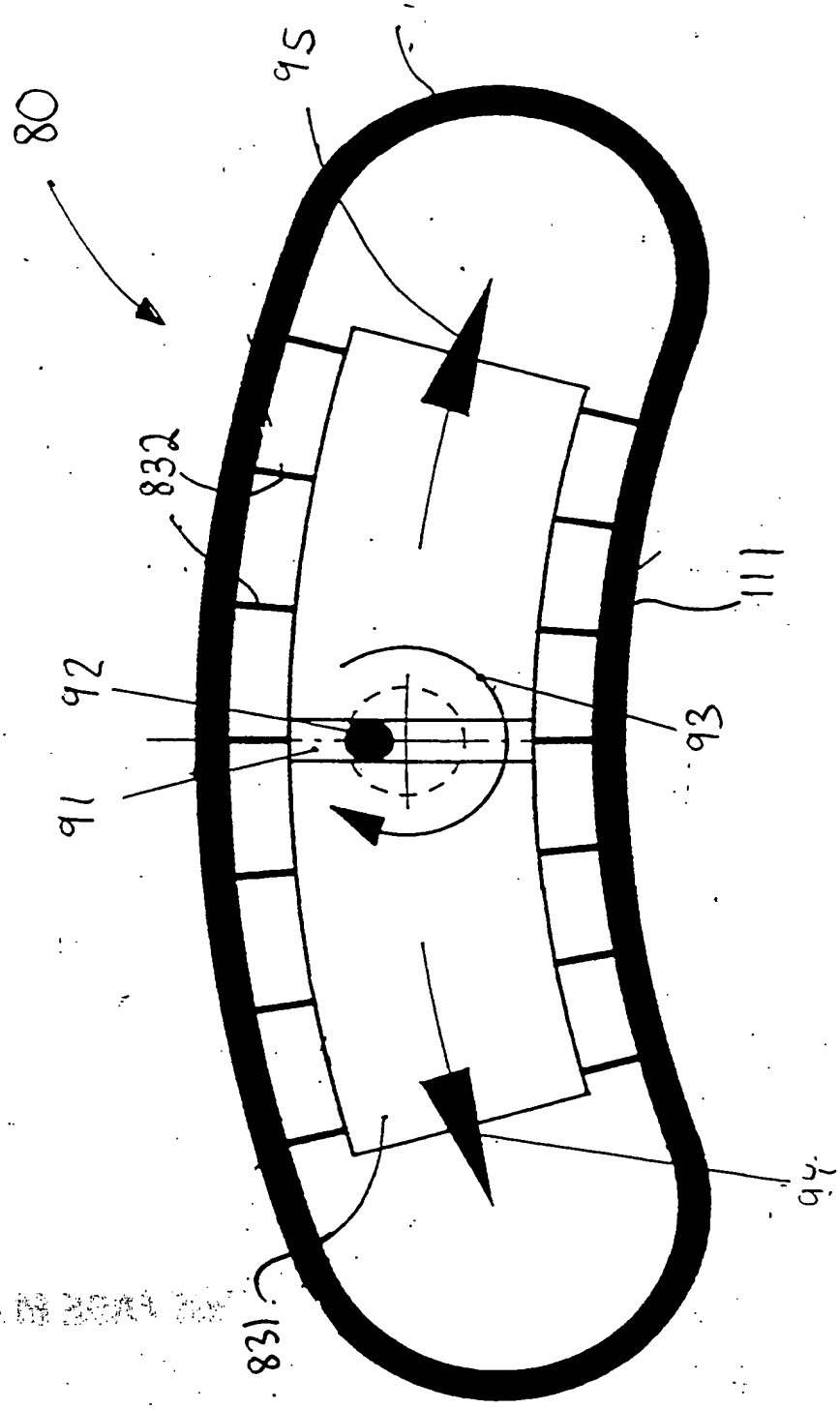


Fig. 9

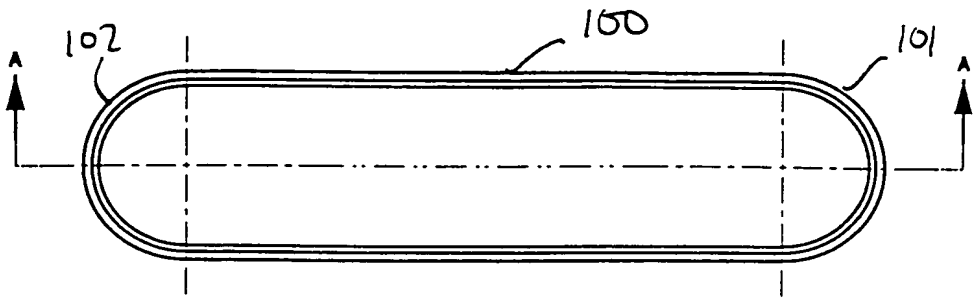


Fig. 10

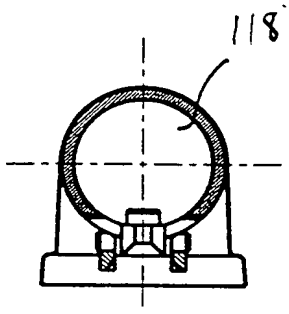


Fig 12

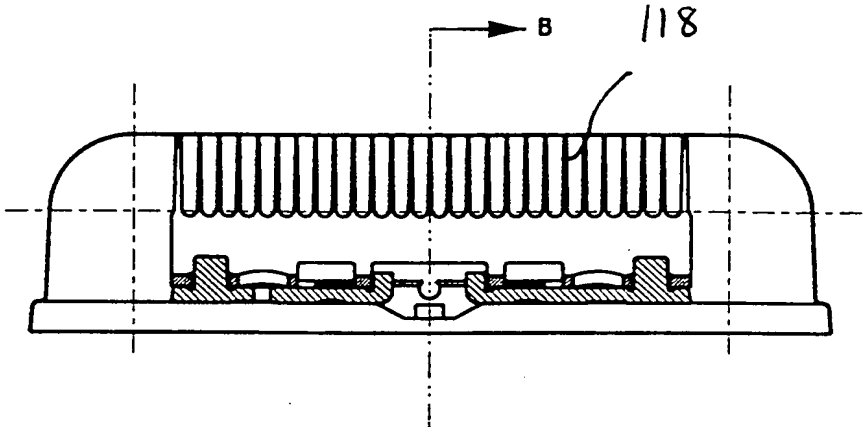


Fig 11

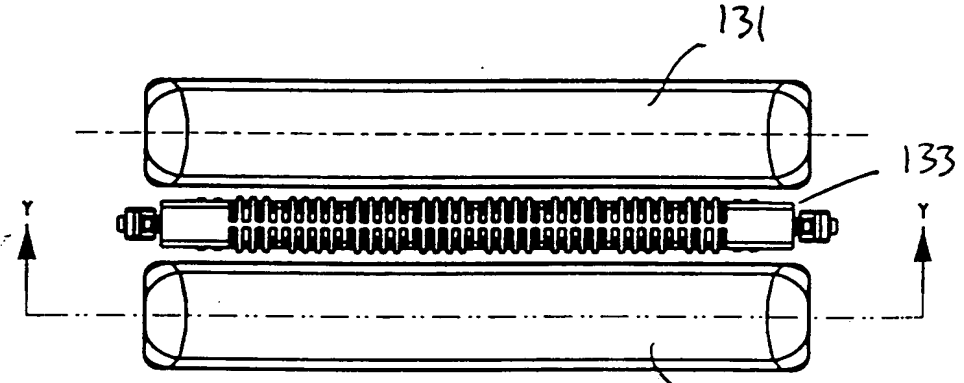


Fig 13

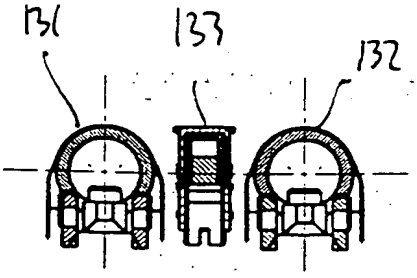


Fig. 15

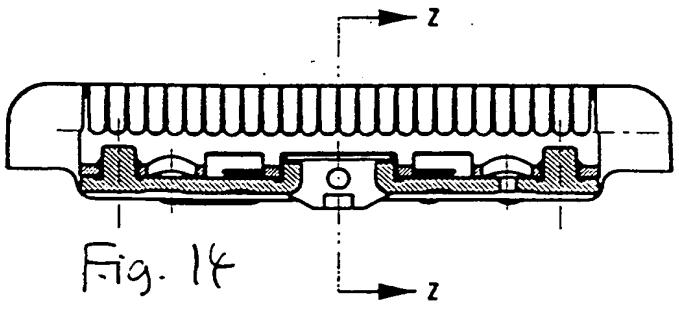


Fig. 14

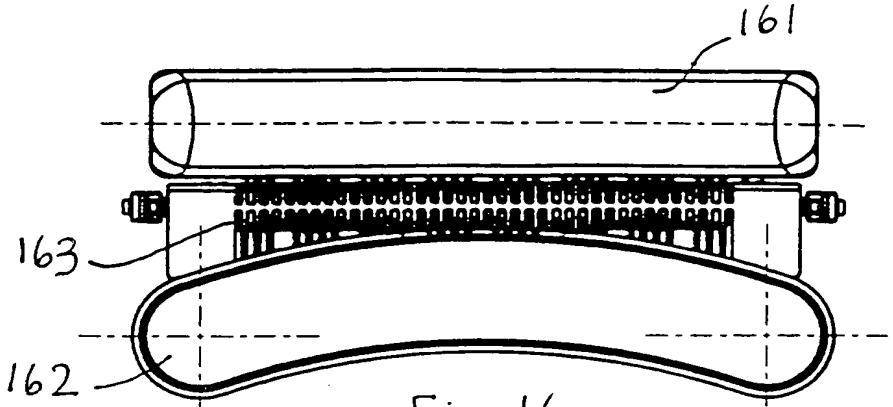


Fig 16

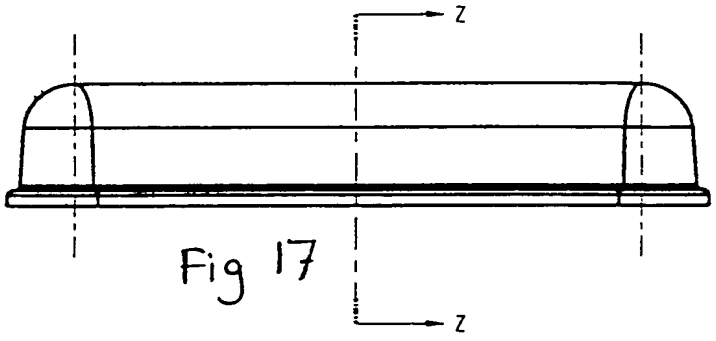


Fig 17

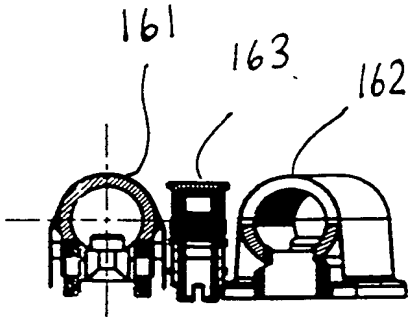


Fig. 18

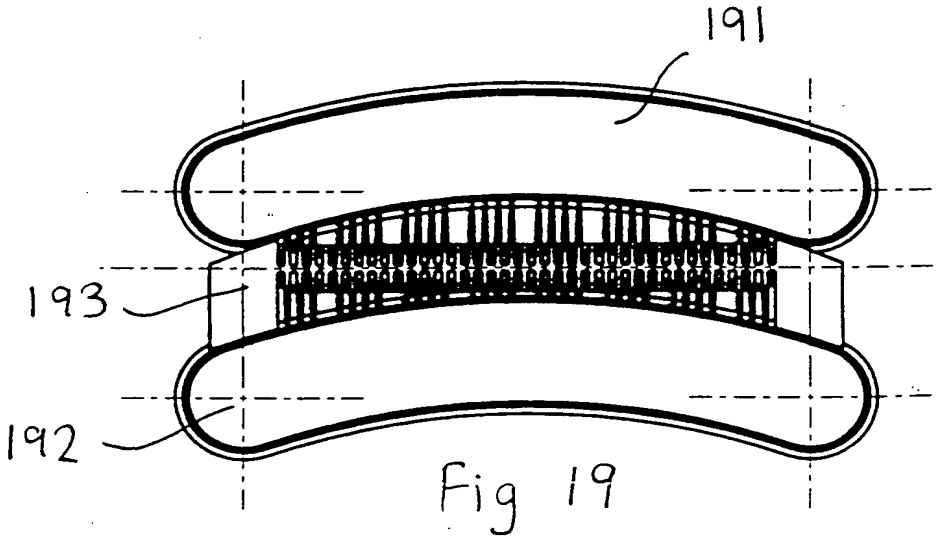


Fig 19

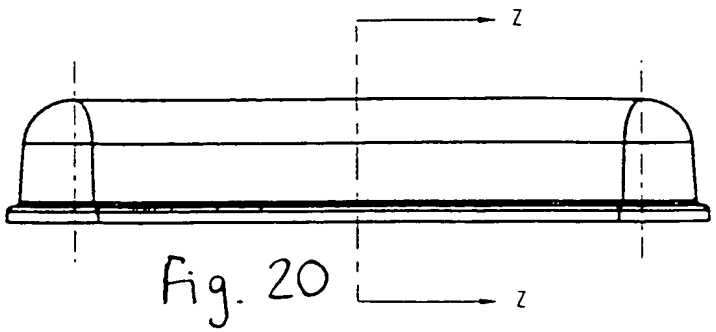


Fig. 20

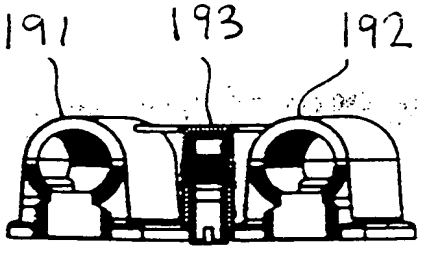


Fig 21

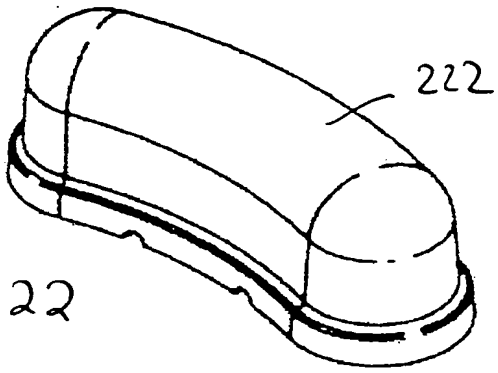


Fig. 22

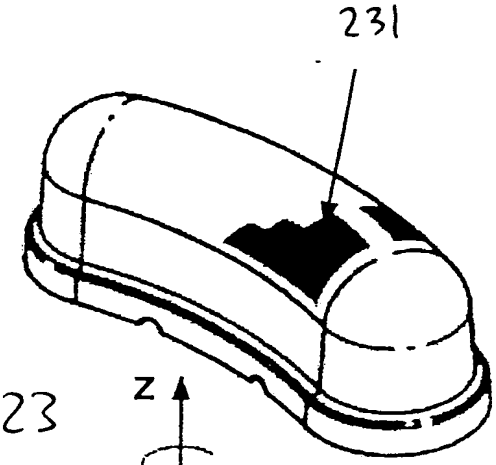
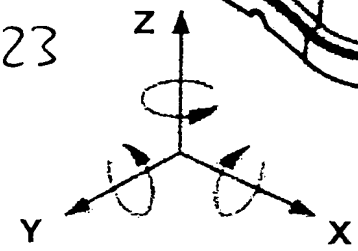


Fig 23



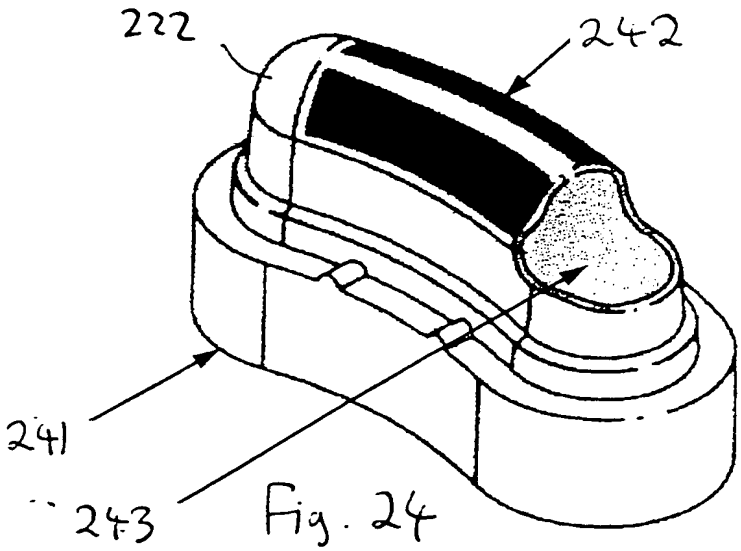


Fig. 24

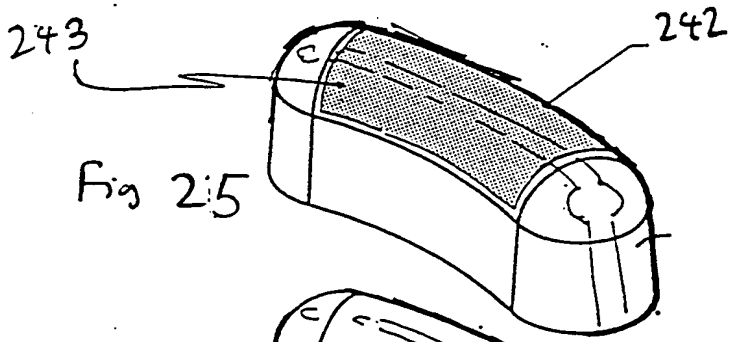


Fig 25

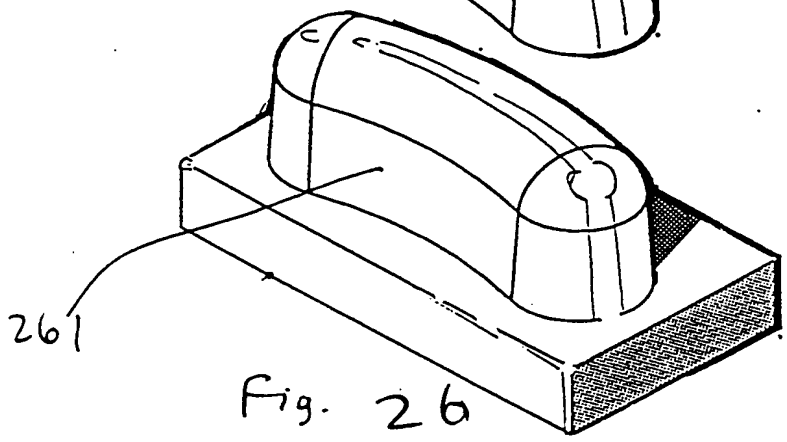


Fig. 26

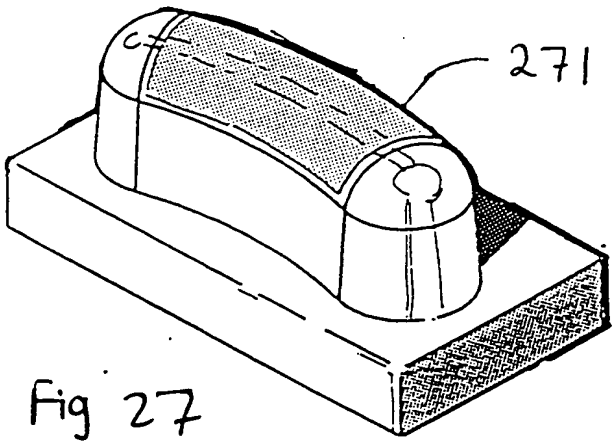


Fig 27

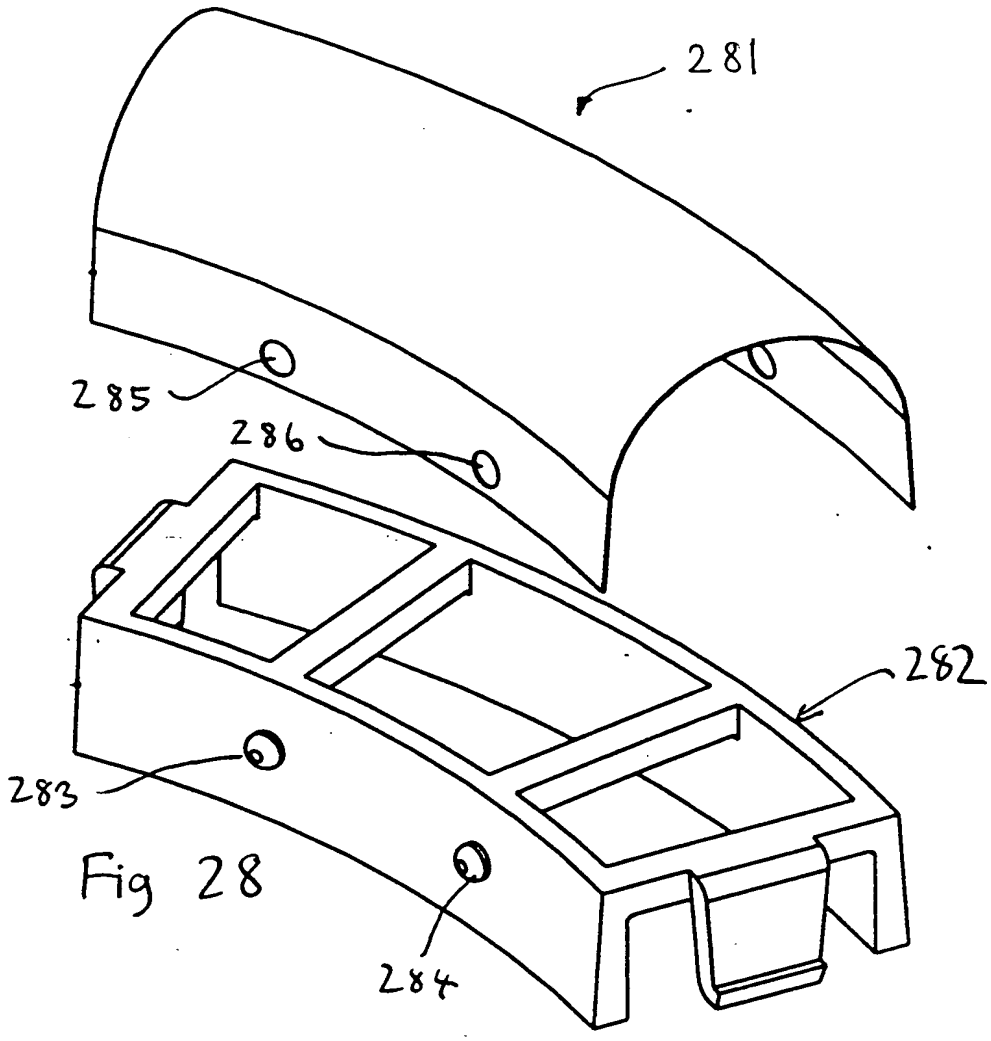


Fig 28

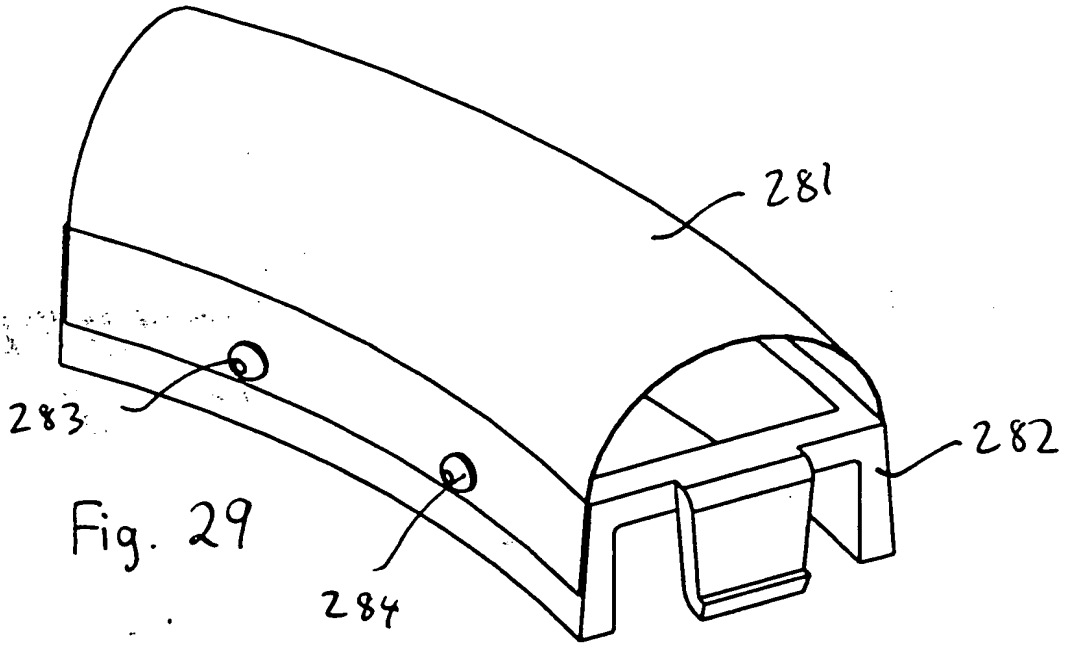


Fig. 29

The Patent Office

The Gillette Company
% Hoffman, Eitle & Partner
Sardinia House
Sardinia Street
52 Lincoln's Inn Fields
LONDON
WC2A 3LZ

The Patent Office
Cardiff Road
Newport
Gwent NP9 1RH

Examiner: 01633 813694
Switchboard: 01633 814000
Fax: 01633 814444

Your Reference: P12199r1/rp
Application No: GB 9708847.0

27 June 1997

Dear Sirs

Patents Act 1977: Search Report under Section 17(5)

I enclose two copies of my search report and two copies of the citations.

Publication

I estimate that, provided you have met all formal requirements, preparations for publication of your application will be completed soon after **22 September 1998**. You will then receive a letter informing you of completion and telling you the publication number and date of publication.

Amendment/withdrawal

If you wish to file amended claims for inclusion with the published application, or to withdraw the application to prevent publication, you must do so before the preparations for publication are completed. **No reminder will be issued.** If you write to the Office less than 3 weeks before the above completion date, please mark your letter prominently: **"URGENT - PUBLICATION IMMINENT".**

Yours faithfully

Hal Young
Examiner

The Patent Office

Application No:	GB 9708847.0	**Examiner:**	Hal Young
Claims searched:	1-15 and in part claims 18-23	**Date of search:**	25 June 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B4B

Int Cl (Ed.6): B26B(19/00, 02, 04, 12, 38)

Other: ONLINE DATABASES: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2272395 A	(MATSUSHITA)	
A	GB 586875	(BELZ)	
A	EP 0148515 A1	(PHILIPS)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.